(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 250 678**
**A1**

# (12) EUROPEAN PATENT APPLICATION

(21) Application number: 86307255.9

(51) Int. Cl.⁴: B62D 65/00 , B62D 27/02

(22) Date of filing: 22.09.86

(30) Priority: 24.06.86 GB 8615401

(43) Date of publication of application:
07.01.88 Bulletin 88/01

(84) Designated Contracting States:
AT BE CH DE FR GB IT LI LU NL SE

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## (54) Improvements in automobile body building methods and apparatus.

(57) In a method of building an automobile body separate upper and lower body modules (50, 78) are formed, incorporating the roof area and the floor area of the automobile respectively, precision mating locations (62) on the body modules are used first as reference for fitting interior parts and equipment to the respective modules and then for fitting the modules together. An assembly line for carrying out the method has respective sets of stations for forming operations on upper and lower body modules, a mating station (30) at which the two modules are brought together and a joining station (32) where they are, for example, welded.

The leading station (20, 22) in each set determines a master body point (64, 82) on a module presented to it, and forms the mating locations (62) on the module with reference to the master body point.

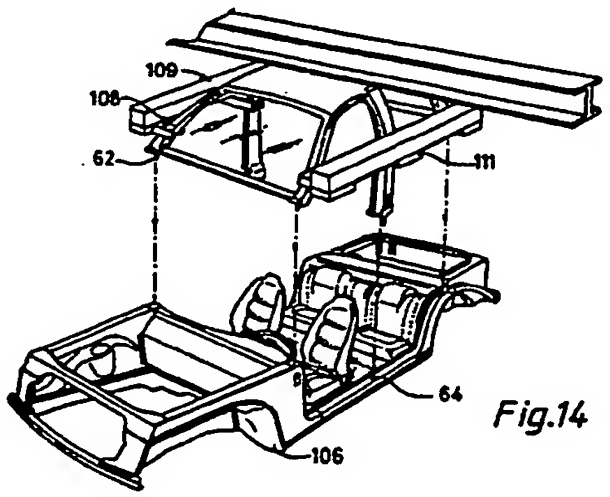


Fig.14

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# Improvements in Automobile Body Building Methods and Apparatus

## Field of the invention

This invention relates generally to method and apparatus for building and assembly of automobile bodies.

## Background to the invention

It has been and remains conventional practice in the automobile industry for car bodies to be build as an open box structure into which are fitted and fixed all the body space parts and equipment such as the dashboard, instrument panel, wiring loom, roof lining, sound deadeners, carpets, front and rear seats, etc.

It is a general aim of this invention to provide an improved method and apparatus for automobile body building which has substantial advantages over the conventional practice, as will be made clear hereinafter.

## The invention

According to one aspect of the present invention, a method of automobile body building comprises the steps of:

-forming an upper body module incorporating the roof area;

-forming a lower body module incorporating the floor;

-precision forming mating locations on the upper and lower body modules;

-utilising the locations on the upper module as references for the fitting of interior parts and equipment into said upper module;

-utilising the locations on the lower module as references for the fitting of interior parts and equipment into said lower module;

-fitting the upper and lower modules together by use of said mating locations after said interior parts and equipment have been fitted into both modules.

In a preferred method, a master body point is selected and location masters cooperate with the upper and lower body modules at said master point, whilst the mating locations are provided on each module in precise positional relationship to the location master cooperating with said module.

The method is preferably carried out on an assembly line which includes a series of stations, one set for the upper module and one set for the lower module. A leading station in each set enables the locations to be provided on the respective module, in each case with reference to the master body point, and successive subsequent stations in each set utilise the locations to define reference axes in the respective module enabling the precision mounting of sub-assemblies which constitute the required interior parts and equipment. The two modules are then brought together at a mating station, from which the two mated parts pass to a joining station such as a laser welding station.

According to another aspect of the invention, therefore, apparatus for automobile body building comprises two sets of work stations, the first set comprising a leading station at which an upper body module incorporating the roof area is formed with a set of locations with reference to a master body point and one or more subsequent stations at which sub-assemblies are fitted to the upper module utilising the locations on said module to define reference axes which enable precision mounting of said sub-assemblies, the second set of work stations comprising similar leading and subsequent stations for the lower module, a mating station at which the upper and lower modules each with fitted sub-assemblies are mated together by use of the respective locations on the two modules, and a joining station at which the mated upper and lower modules are permanently fixed together.

An important aspect of the invention concerns a preferred structure of the mating locations formed on the upper and lower modules. In this preferred arrangement, one module is provided with precision drilled holes and the other module is provided with precision turned pins for precisely mating with the holes. When the two modules have been accurately located in mating engagement, as by means of a vision unit, locking in the mated condition prior to permanent joining may be achieved by forming the pins as hollow cylinders, enabling passage of a bolt carrying a threaded tapered plug, whereby rotation of the bolt, as by means of a nut runner, draws the plug into the hollow pin to expand it into tight engagement in the hole in which it is located. The positions of the car body at which joints between the modules are located are desirably such that they can be covered, as by plastics panels in the case of a space frame body construction or by finishing covers in the case of a monocoupe body construction. A monocoupe body construction will include a roof formed as an integral part of the upper module.

Advantages obtainable from the invention are that the same lower module can be employed to mate with saloon, coupe or other module types, that greater flexibility in body style is enabled, that model changes are rendered easier and at less



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cost in making the change, that upper and lower module construction and module mating and joining can respectively be carried out at different sites, and that overall plant area for production is reduced. The invention is applicable to both space frame and monocoupe body types, and painting of both upper and lower modules is preferably completed prior to carrying out the invention, so that a finish paint operation may sometimes be avoidable. In any event, the invention also simplifies application of exterior body trims, fender mouldings and the like.

## Description of drawings

The invention will now be exemplified with reference to the accompanying drawings, in which:-

Figure 1 shows a process lay-out in a production plant;

Figure 2 shows an upper body module in a machining station;

Figures 3 to 5 respectively show an upper body module in successive trim application stations;

Figure 6 shows a lower body module in a machining station;

Figures 7 to 12 respectively show a lower body module in successive trim application stations;

Figure 13 shows a finished lower body module;

Figure 14 shows a mating station at which upper and lower body modules are mated together;

Figure 15 shows a joining station;

Figure 16 shows the general principle utilised in a preferred structure of mating locations;

Figures 17 to 19 respectively show the form of joining preferred at the respective individual mating locations; and

Figure 20 illustrates the adaptability of the process to differing model types.

## Description of embodiment

Referring to Figure 1, a typical layout in a processing plant is illustrated, for building an automobile body in accordance with the invention.

A paint process line 14 receives upper and lower body modules from respective upper and lower module construction sites 10 and 12. The upper and lower modules emergent from paint processing take separate paths through two sets of work stations, each set commencing with a vertical buffer station, designated 16 for the upper module and 18 for the lower module. The vertical buffer stations 16 and 18 are followed by respective machining stations 20 and 22 for the upper and lower modules. The modules, each with machined mating locations thereon, then pass to a succession of trim application stations, designated 24 and 26 for the upper and lower modules, respectively, at which the various interior parts and equipment are precision fitted to the modules, making use of references defined by the machined locations. The completed lower modules then pass through a sealer and/or adhesive station 28 to a mating station 30 to which the completed upper modules are also fed. At the mating station 30, upper and lower modules are mated together in pairs, before passing to a joining station 32 at which they are permanently joined, as by laser welding. Subsequent stations are for assembly steps effected after the basic automobile body has been assembled in accordance with the invention, and include injection moulding stations 34, a chassis line 36, and a line 38 for application of side mouldings at 40, rear quarter mouldings at 42, fenders at 44 and doors at 46, and possibly application of a hood and deck at 48.

It will be noted that the trim application line 24 for the upper modules includes an inverting station 25.

Referring now to Figure 2, reference 50 denotes an upper body module as received in the machining station 20 from the paint process line. The module 50 is held in clamps 53 on a clamping buck 52. At the bottom of each of the six posts of this module, which may be called the pair of front posts 54, the pair of centre posts 56 and the pair of rear posts 58, a turning tool 60 giving a precision outside diameter acts on the module to form a hollow locating pin 62. The action of these tools is computer controlled, and precisely fixes the position of the locating pins relative to a location master 64 at the bottom of one of the centre posts. This location master 64 corresponds to a master body point which constitutes a basic datum for relative positioning of parts throughout the process. Relative to the location master 64, the other locations 62 define reference axes which enable parts to be fitted with precision, and subsequently enable the upper and lower modules to be precisely mated together over their entire extent.

Figure 3 shows a trim application station at which an inside roof headlining 66, post trims 68 and an electrical wiring loom 70 are precision fitted to the upper module after inversion of the latter. Although not shown, the upper module may include a steel roof. The module could be a finish painted unit.



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Figure 4 shows the precision fitting of backlight 72 and windshield 74 in the inverted upper module, the glass being bonded in position at this station, whilst Figure 5 illustrates the application of a plastics roof 76, which step could be transferred to the final line 38.

It is to be noted that the locating pins 62 serve in all these trim application stages in effect to define reference axes through the module which enable the accurate and precise positioning of the parts to be fitted by robotic positioning and fitting equipment.

Figure 6 shows a lower body module 78 as received in the machining station 22 from the paint process line. This module 78 is likewise clamped in position, and is drilled with holes by precision drill units 80, computer controlled with reference to a location master 82 so that the holes constitute locations precisely matching the locating pins 62 precision formed on the upper module subsequently to enable mating therewith.

Figures 7 to 12 show successive trim application stations at which the following sub-assemblies or trims are fitted to the lower body module, again making use of the machined locations to define references enabling the precision fitting of parts by robotic equipment. In Figure 7, reference 84 denotes the main wiring loom with connection structure 86. In Figure 8, reference 88 denotes the console brackets, 90 the acoustic deadeners, 92 the heat shield, 94 the exhaust hanger. In Figure 9, reference 96 denotes the instrument and dashboard sub-assembly. In Figure 10, reference 98 denotes the carpets and reference 100 the rear seats. In Figure 11, reference 102 denotes the front seats, whilst in Figure 12 reference 104 denotes the rear trunk or boot sub-assembly.

Figure 13 shows a completed lower body module.

Following the completion of the upper and lower modules, they pass in pairs to a mating station shown in Figure 14. The completed lower module 106 is precisely located, and the completed upper module 108 carried by clamp 109 is located into engagement therewith at the mating locating pins and holes. Precise location is by vision units and preferably vision set servo-mechanisms 111. As will be clear from a subsequent description of Figure 16, automatic nut runners are applied to the structure locating points to expand locating plugs to correct torque settings, and thus fix the upper and lower body modules together. Registration of the location masters 64 ensures that the locating pins and holes mate together substantially without any requirement for bending or flexing equipment to distort any part of either module, which retain their original production shapes during trim application due to use of the location masters as a basic datum throughout the process.

From the mating station, the locked together upper and lower modules forming automobile body 109 pass to the joining station shown in Figure 15, wherein the reference 110 denotes a gantry or floor mounted robotic laser welding unit. Reference 112 denotes the site of a possible mechanical lock effected between the modules, whilst reference 114 denotes pusher units which may be employed to assist panel fitting.

Figure 16 shows the principal of the structure which is employed at the mating locations. In this figure, the precision turned locating pin on the upper module 118 is referenced 116 and the precision drilled locating hole in the lower module 122 is referenced 120. A nut runner 124 is employed to tighten bolt 126, drawing up the conical plug 128 in order to expand the locating pin 116 into tight engagement in the locating hole 120. As previously mentioned, relative positioning of the modules is assisted by use of a vision unit. A sealing and/or structural adhesive compound may also be employed at the joint.

Figures 17 to 19 show the individual joints in more detail, respectively at the bottom of the front, centre and rear posts of the upper module at which said module is joined with the lower module.

Figure 17 refers to the bottom of the front post 58, and the following references are employed to denote the various parts and components:-

130 - hood or plastics cowl top
132 - front fender of plastics or steel
134 - mechanical or laser joint
136 - mating locations
138 - structural adhesive or sealer
140 - glass bonded to upper module
142 - door

Reference 144 indicates a height datum defined by the mating locations.

In Figure 18, which refers to the centre post 56, the following references are used:-

146 - flanges
148 - snap-in plastics finisher
152 - mechanical or laser joint
154 - laser welds
156 - mating locations. The location master at this point defines centre line (C.L.) and longitudinal (Fwd) axes, as indicated.

Figure 19 shows the joint at the rear post 54, in the case of a monocoupe body. In this figure the following references are used:-

158 - rear post plastics moulding
160 - mating locations
162 - height datum defined by mating locations
164 - laser weld



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168 - lower module
170 - glass bonded to upper module
172 - plastics moulding
174 - laser or mechanical joint
176 - structural adhesive or sealer

Finally, Figure 20 shows the versatility of construction afforded by the invention. A common lower module 178, having an optional extension 180, may be mated with a coupe upper module 182, a sedan upper module 184 or a wagon or van upper module 186. In a space frame construction, bonded exterior plastics may provide an outer skin, whilst in a monocoupe or sedan, suitable cover mouldings may cover the module joints.

The method and apparatus as exemplified with reference to the drawings may be modified in various ways within the scope of the invention hereinbefore defined.

## Claims

1. A method of automobile body building characterised by the steps of:
-forming an upper body module (50) incorporating the roof area;
-forming a lower body module (78) incorporating the floor;
-precision forming mating locations on the upper and lower body modules;
-utilising the locations on the upper module as references for the fitting of interior parts and equipment into said upper module;
-utilising the locations on the lower module as references for the fitting of interior parts and equipment into said lower module;
-fitting the upper and lower modules together by use of said mating locations after said interior parts and equipment have been fitted into both modules.

2. A method according to claim 1, characterised in that a master body point is selected and location masters (64, 82) cooperate with the upper and lower body modules at said master point, whilst the mating locations are provided on each module in precise positional relationship to the respective location masters.

3. A method according to claim 2, carried out on an assembly line which includes a series of stations, characterised by one set of stations for the upper module and one set of stations for the lower module.

4. A method according to claim 3, characterised in that a leading station in each set of stations enables the locations to be provided on the respective module, in each case with reference to the master body point, and successive subsequent stations in each set utilise the locations to define reference axes in the respective module enabling the precision mounting of sub-assemblies which constitute the required interior parts and equipment.

5. A method according to claim 4, characterised in that the two modules are brought together at a mating station, from which the two mated parts pass to a joining station such as a laser welding station.

6. A method according to any of claims 1 to 5, characterised in that one module is provided with precision drilled holes and the other module is provided with precision turned pins (62) for precisely mating with the holes.

7. A method according to claim 6, characterised in that, when the modules have been accurately located in mating engagement, as by means of a vision unit, locking in the mated condition prior to permanent joining is achieved by forming the pins (116) as hollow cylinders, enabling passage of a bolt (126) carrying a threaded tapered plug (128), whereby rotation of the bolt, as by means of a nut runner (124), draws the plug into the hollow pin to expand it into tight engagement in the hole in which it is located.

8. A method according to any of claims 1 to 7, characterised in that the positions of the car body at which joints between the modules are located are selected such that the locations are covered, as by plastics panels or by finishing covers, in the completed car body.

9. Apparatus for automobile body building according to the method of claim 1, characterised by two sets of work stations, the first set comprising an upstream station (20) at which an upper body module (50) incorporating the roof area is formed with a set of locations with reference to a master body point and one or more subsequent stations (24) at which sub-assemblies are fitted to the upper module utilising the locations on said module to define reference axes which enable precision mounting of said sub-assemblies, the second set of work stations comprising similar upstream and subsequent stations (22 and 26) for a lower module (78), a mating station (30) at which the upper and lower modules each with fitted sub-assemblies are mated together by use of the respective locations on the two modules, and a joining station (32) at which the mated upper and lower modules are permanently fixed together.

10. Apparatus according to claim 9, characterised in that the upper body module is formed with front, centre and rear posts, and each upstream station (20, 22) includes a computer controlled turning tool (60) for forming cooperating locating pins at the bottom ends of the upper module posts and corresponding locating holes in the lower body module adjacent the edge of the floor, respectively with spatial reference to location



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masters respectively cooperating with the upper module at the bottom of one of the centre posts and at the corresponding centre post matching point on the lower module.



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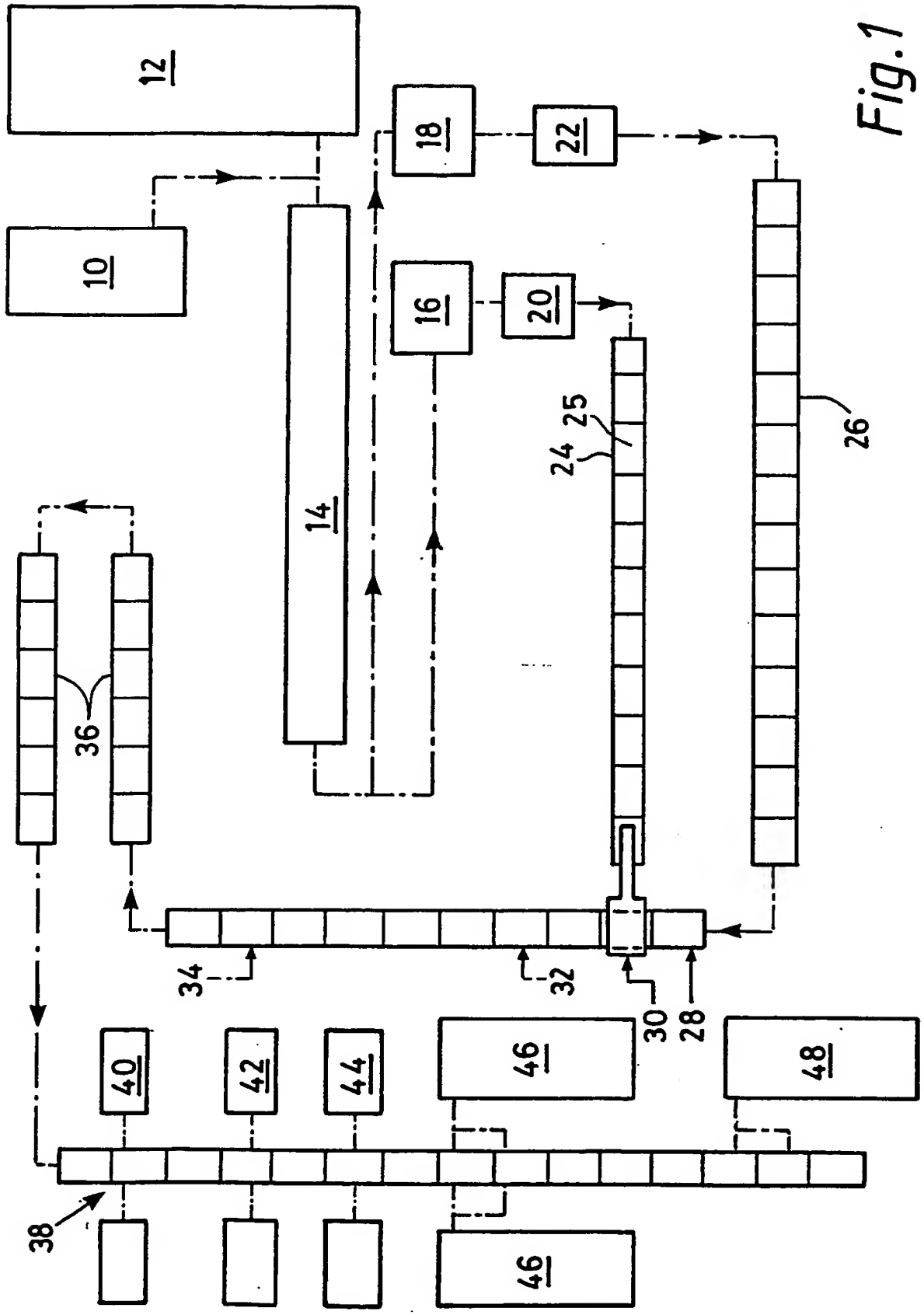


Fig.1

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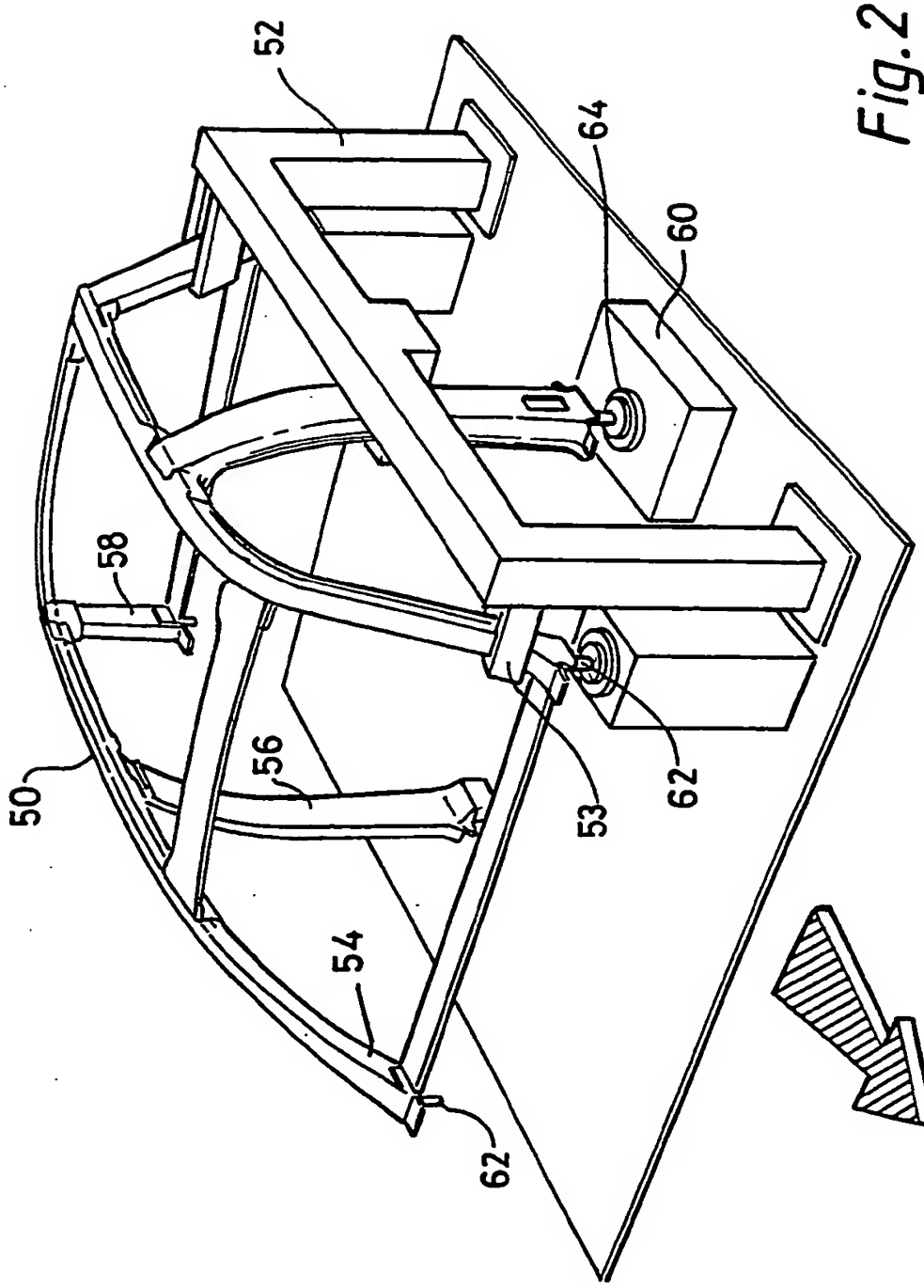


Fig.2

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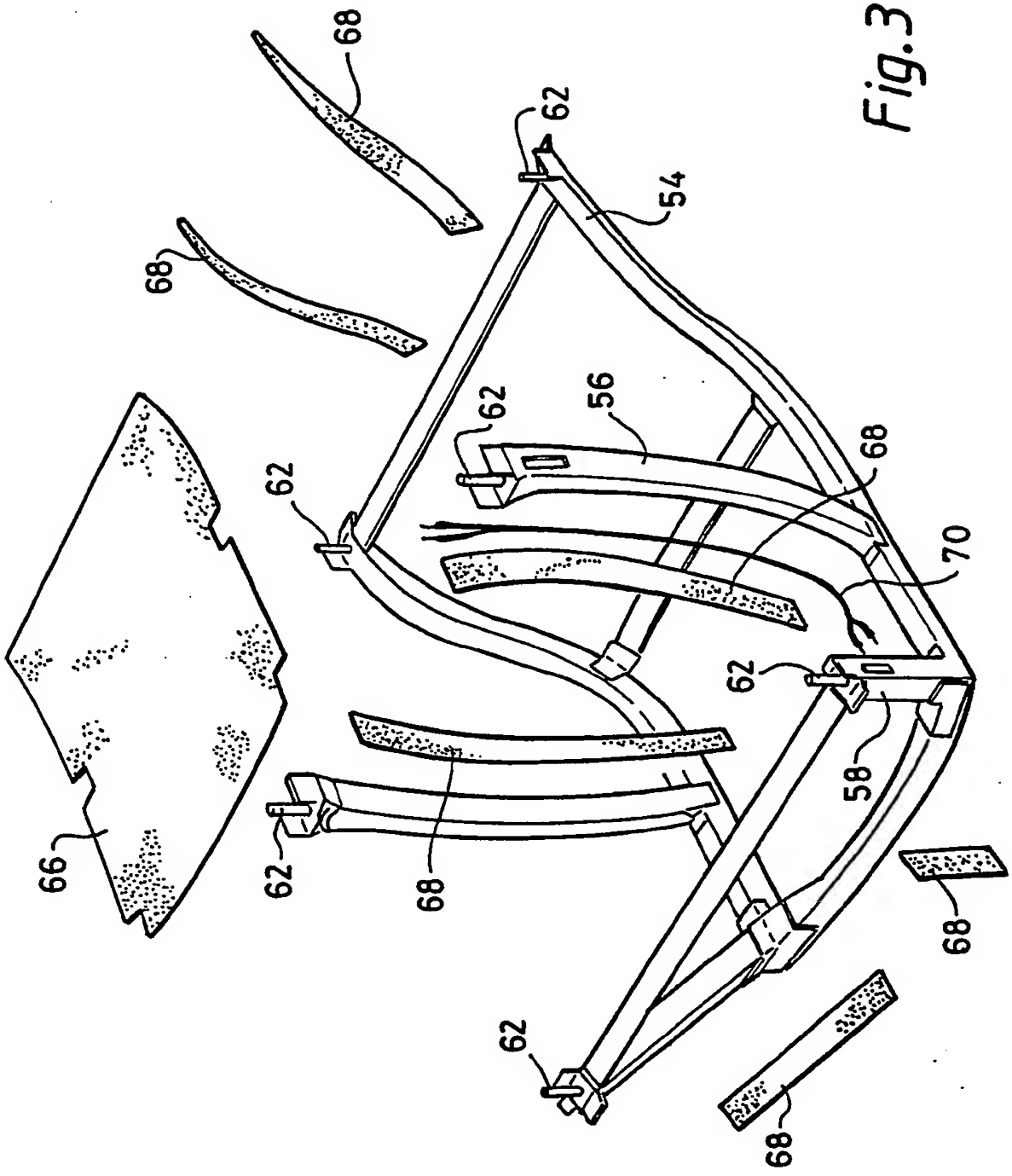


Fig.3

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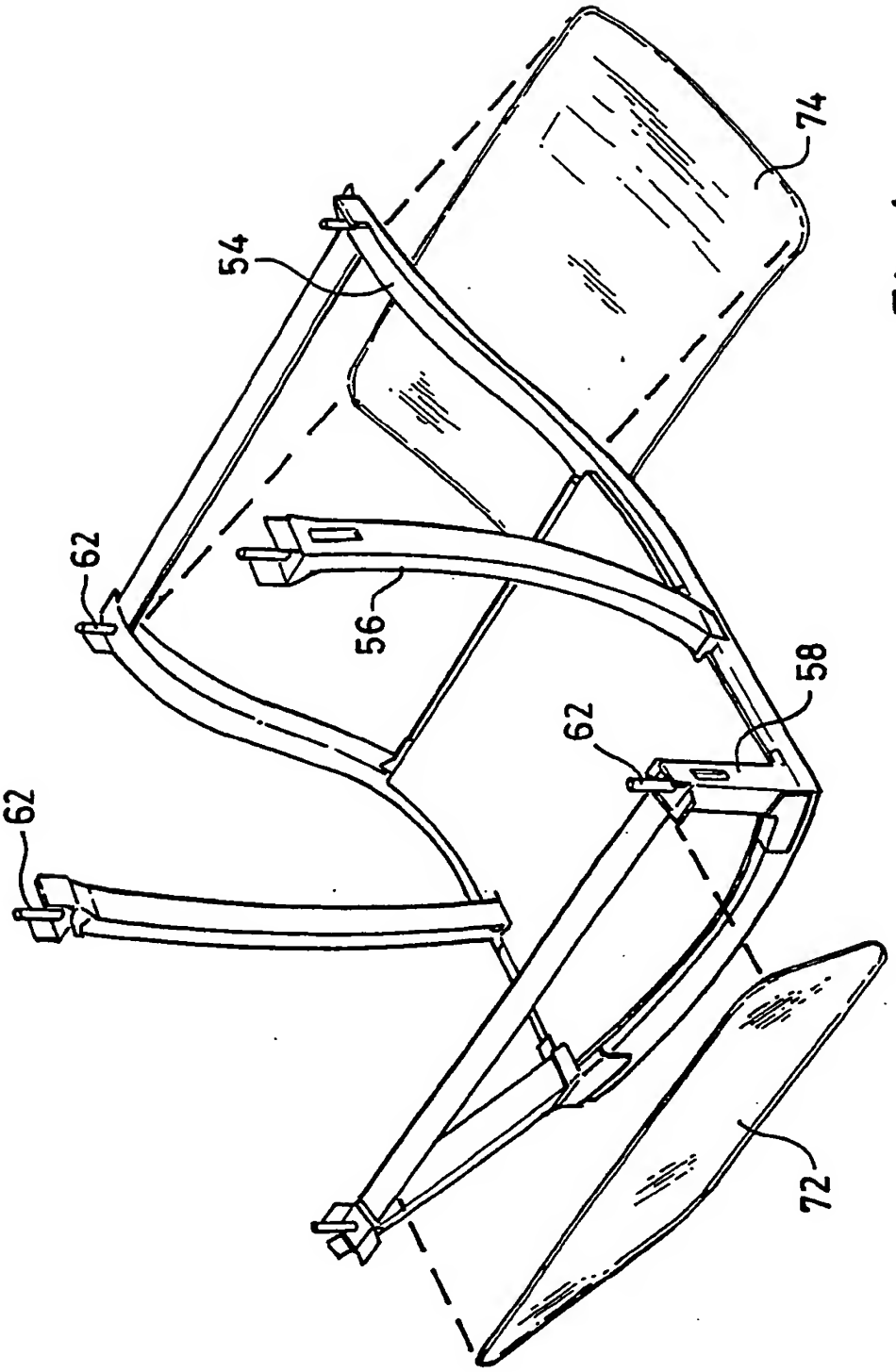


Fig.4

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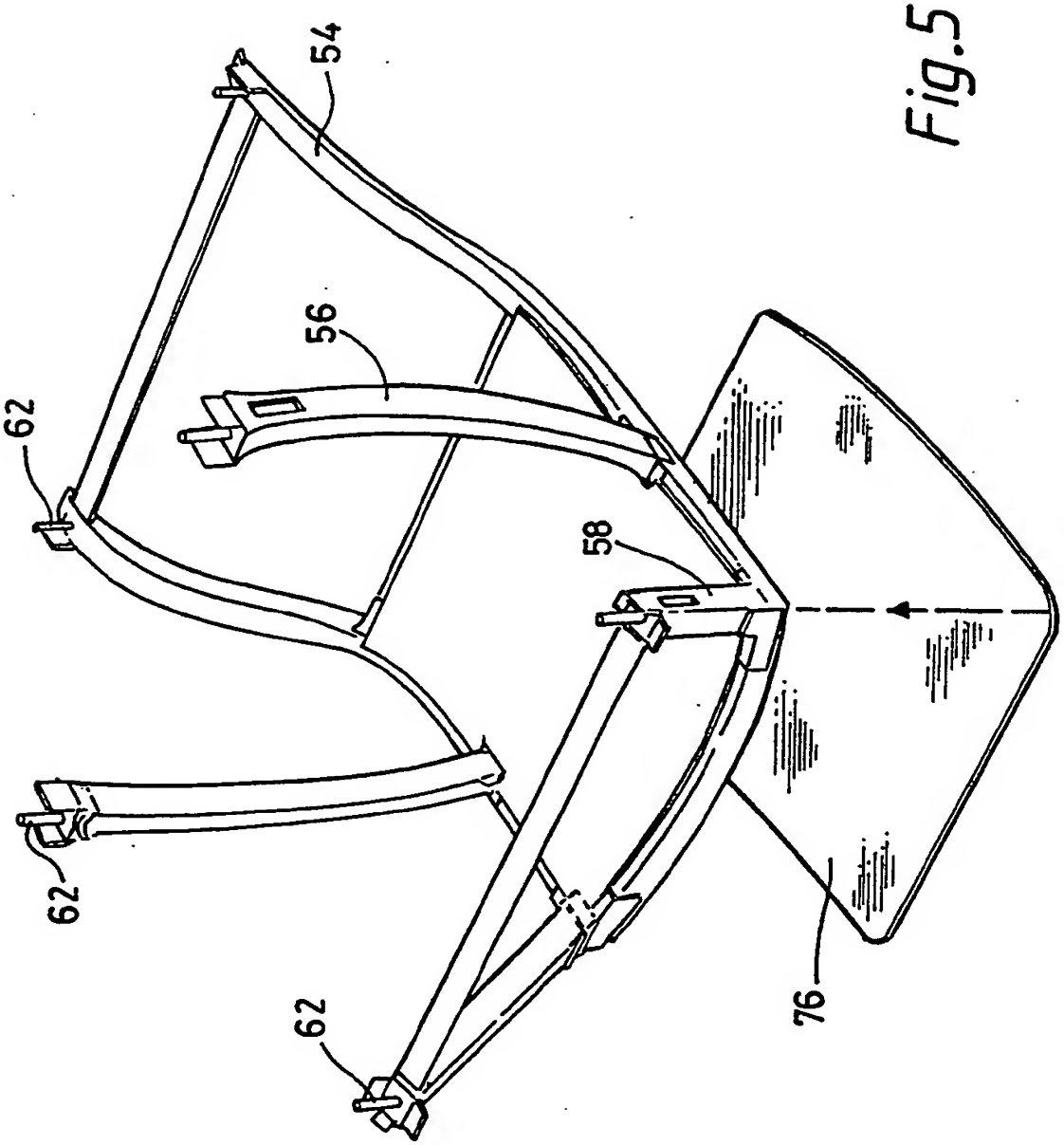


Fig.5

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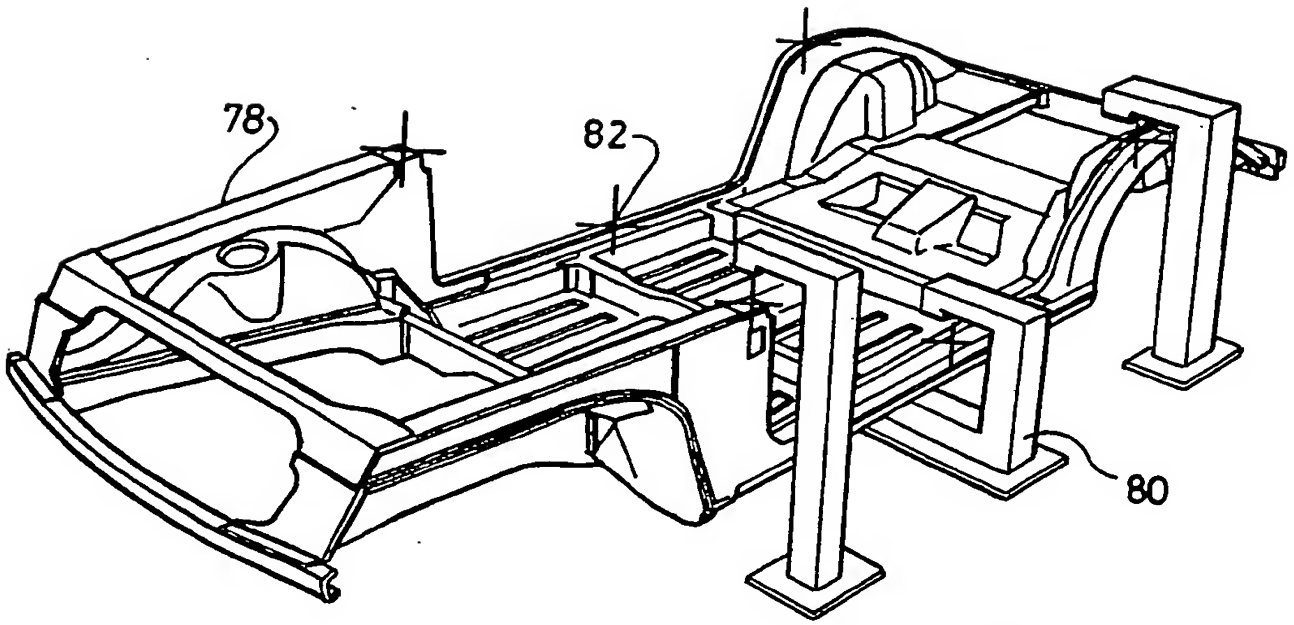


Fig. 6

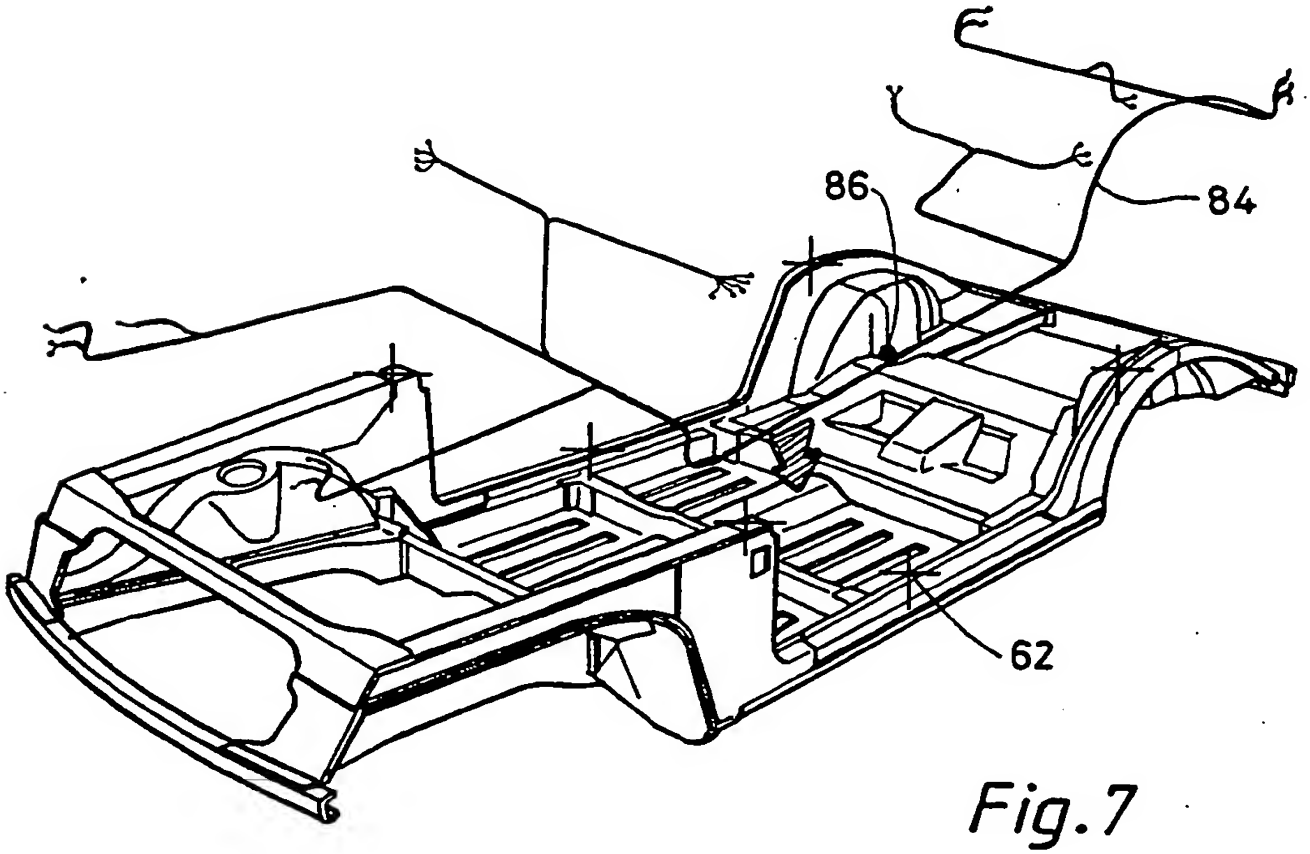


Fig. 7

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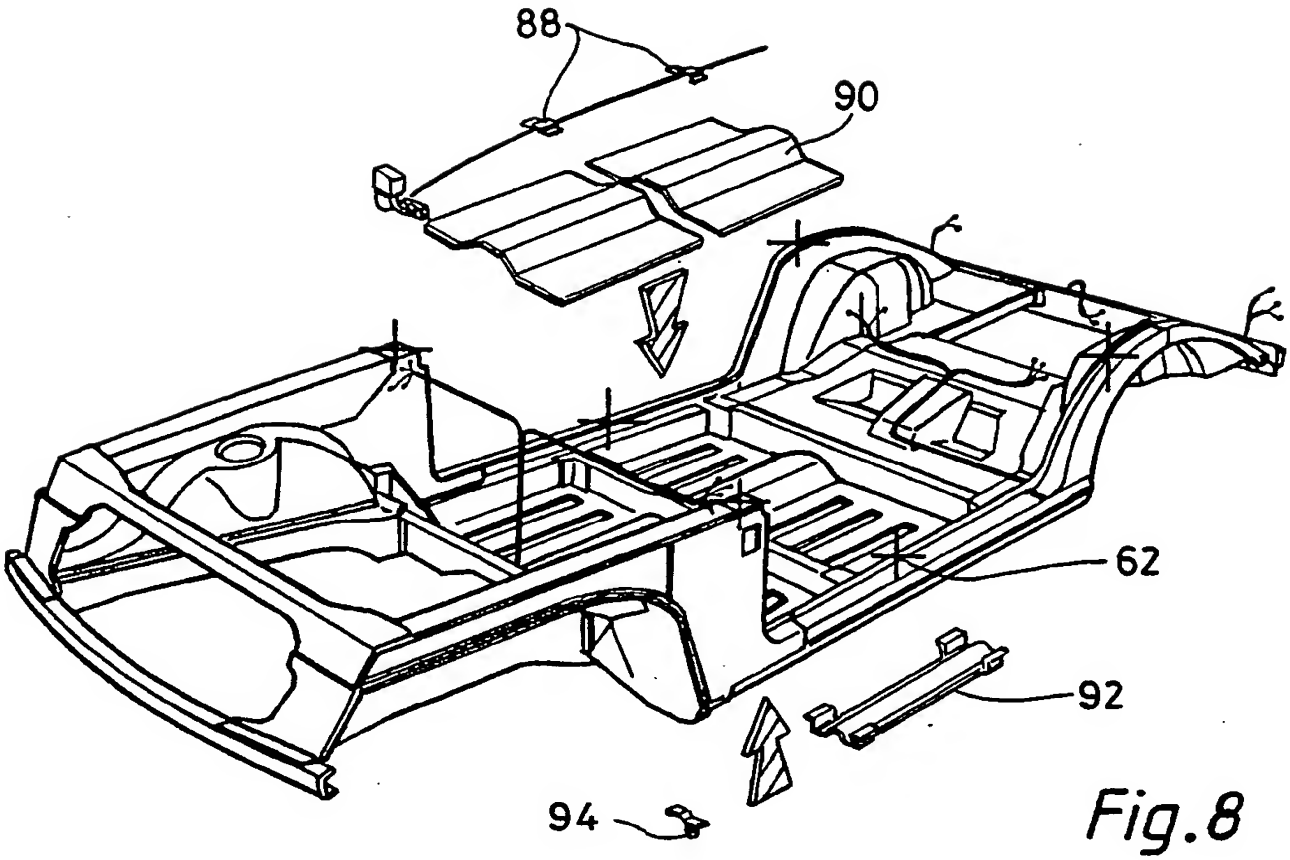


Fig.8

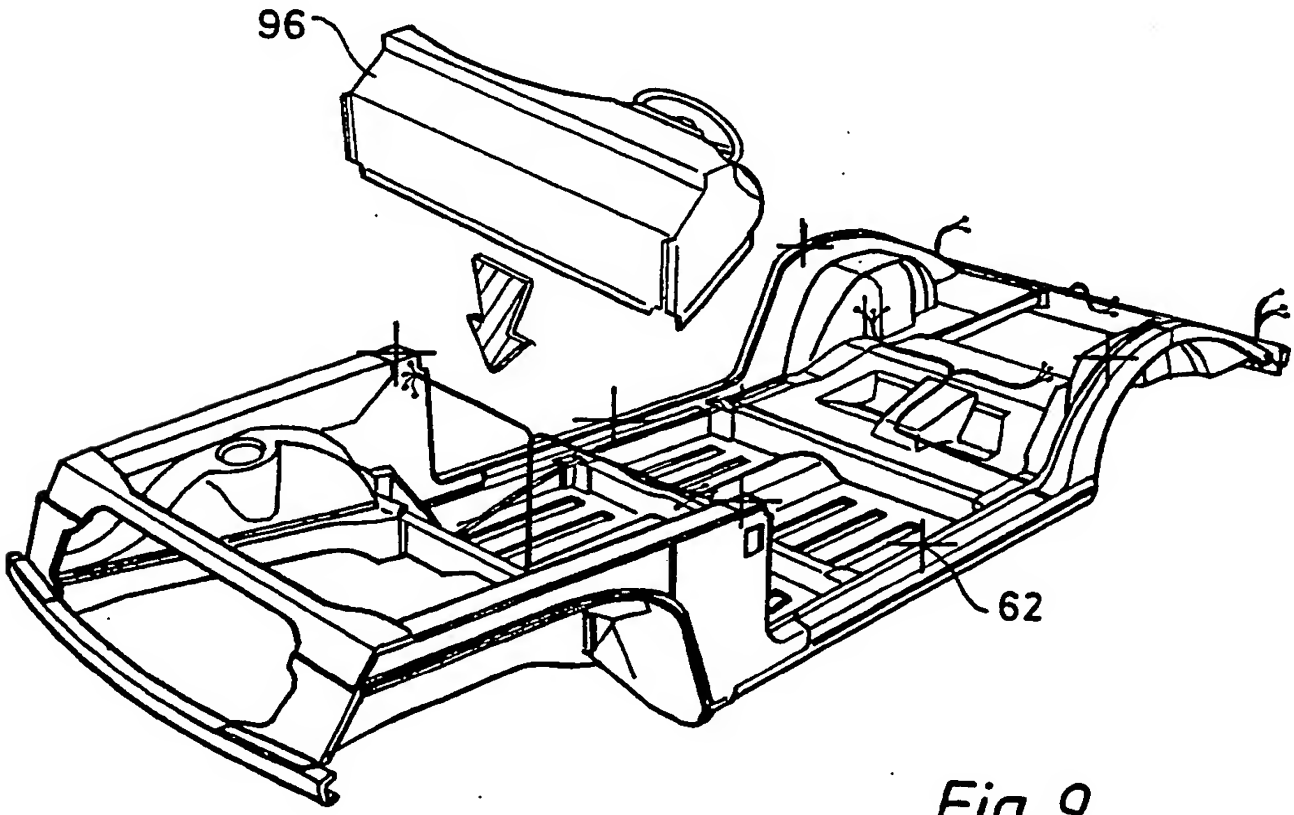


Fig.9

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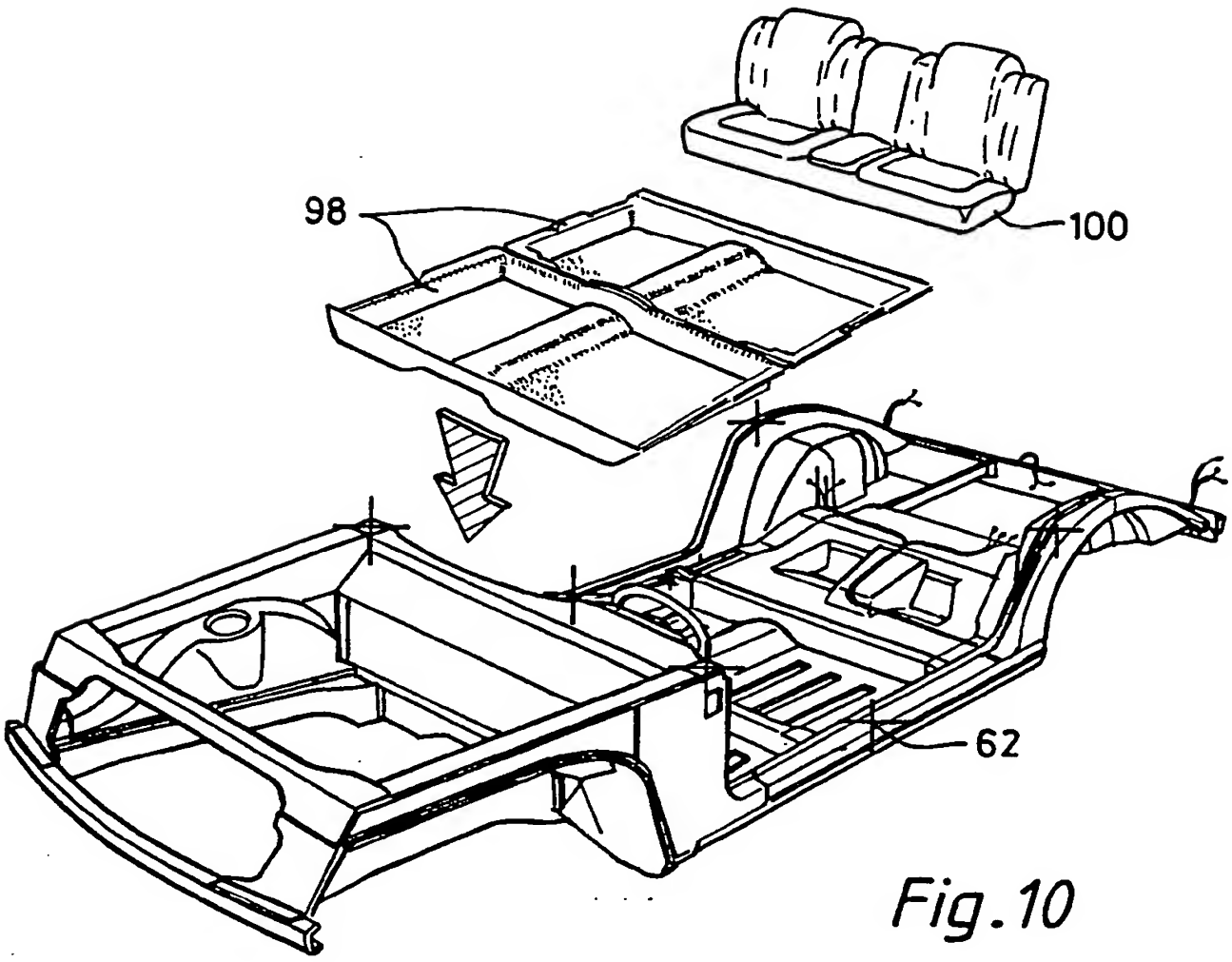


Fig.10

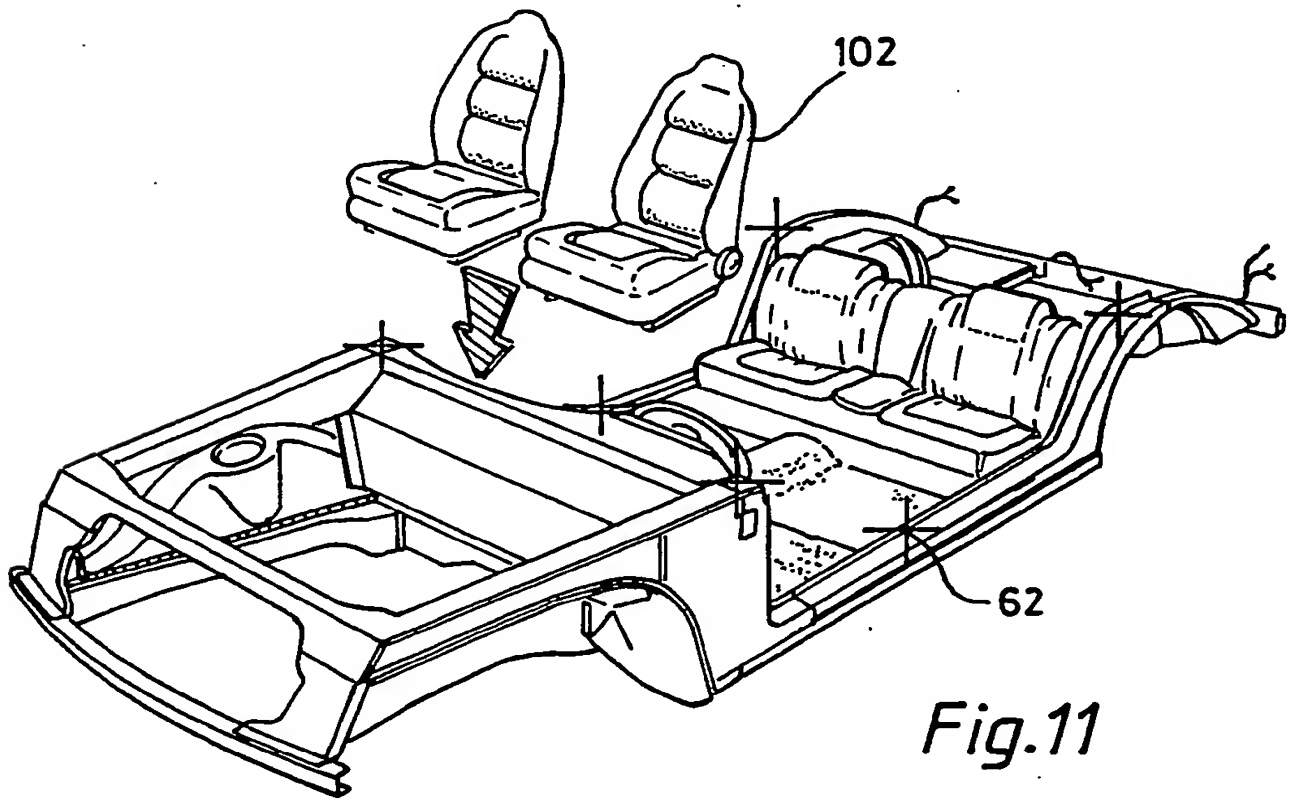


Fig.11

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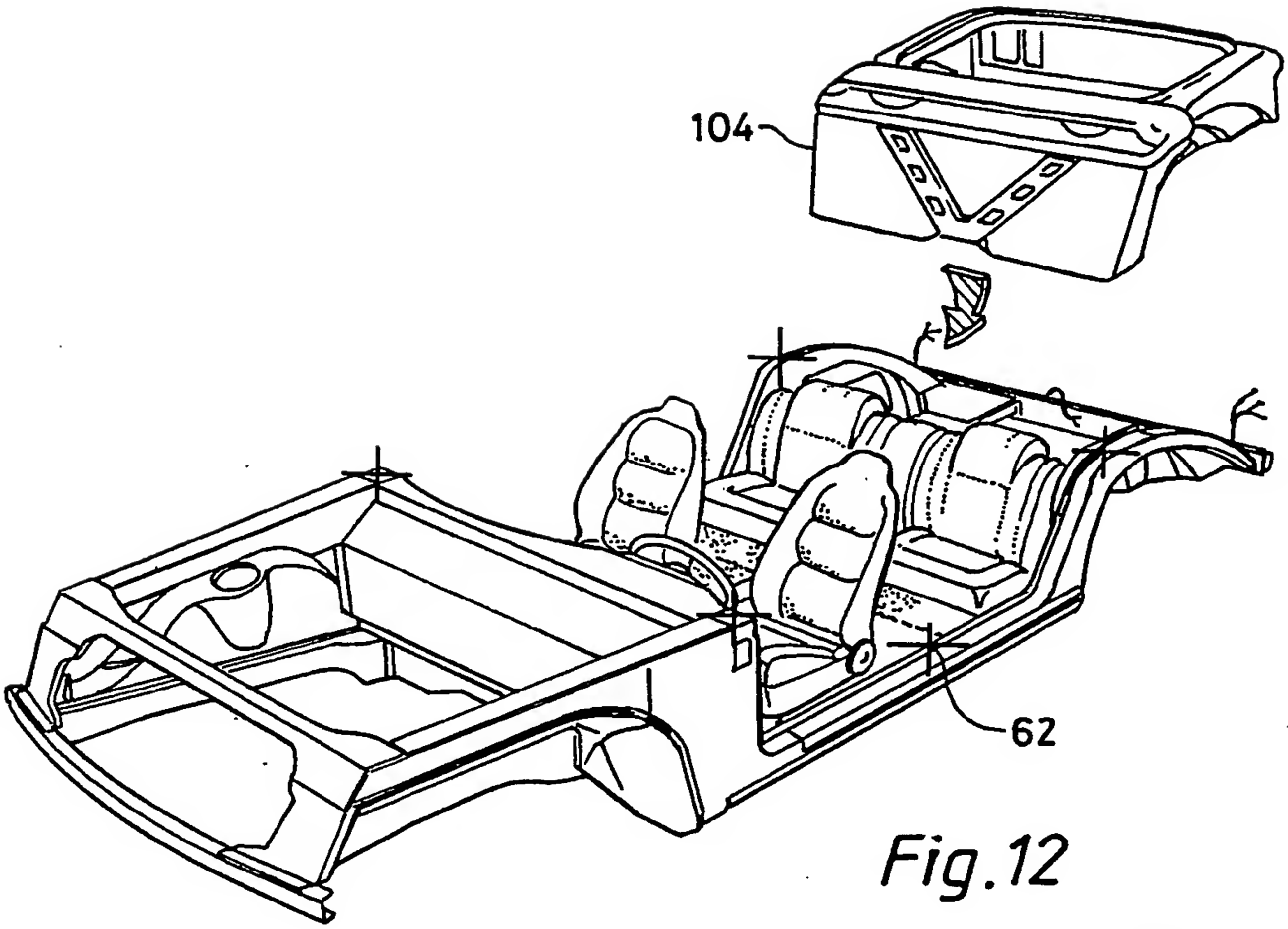


Fig.12

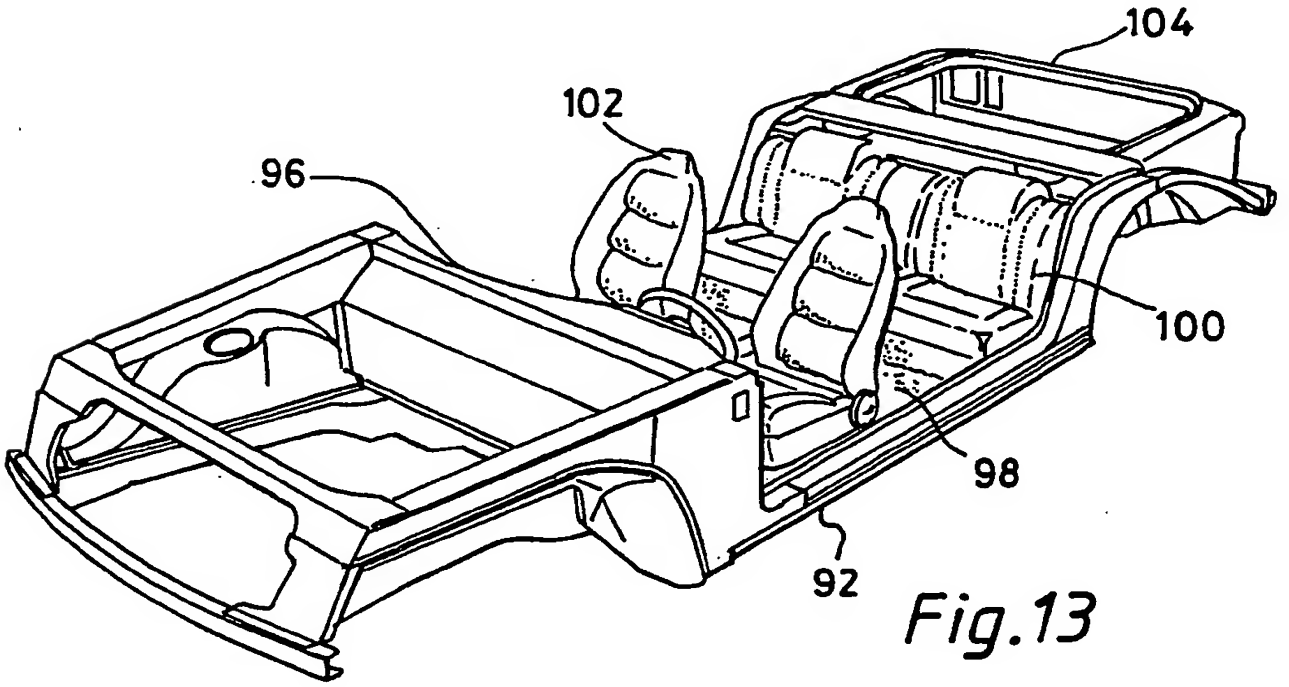


Fig.13

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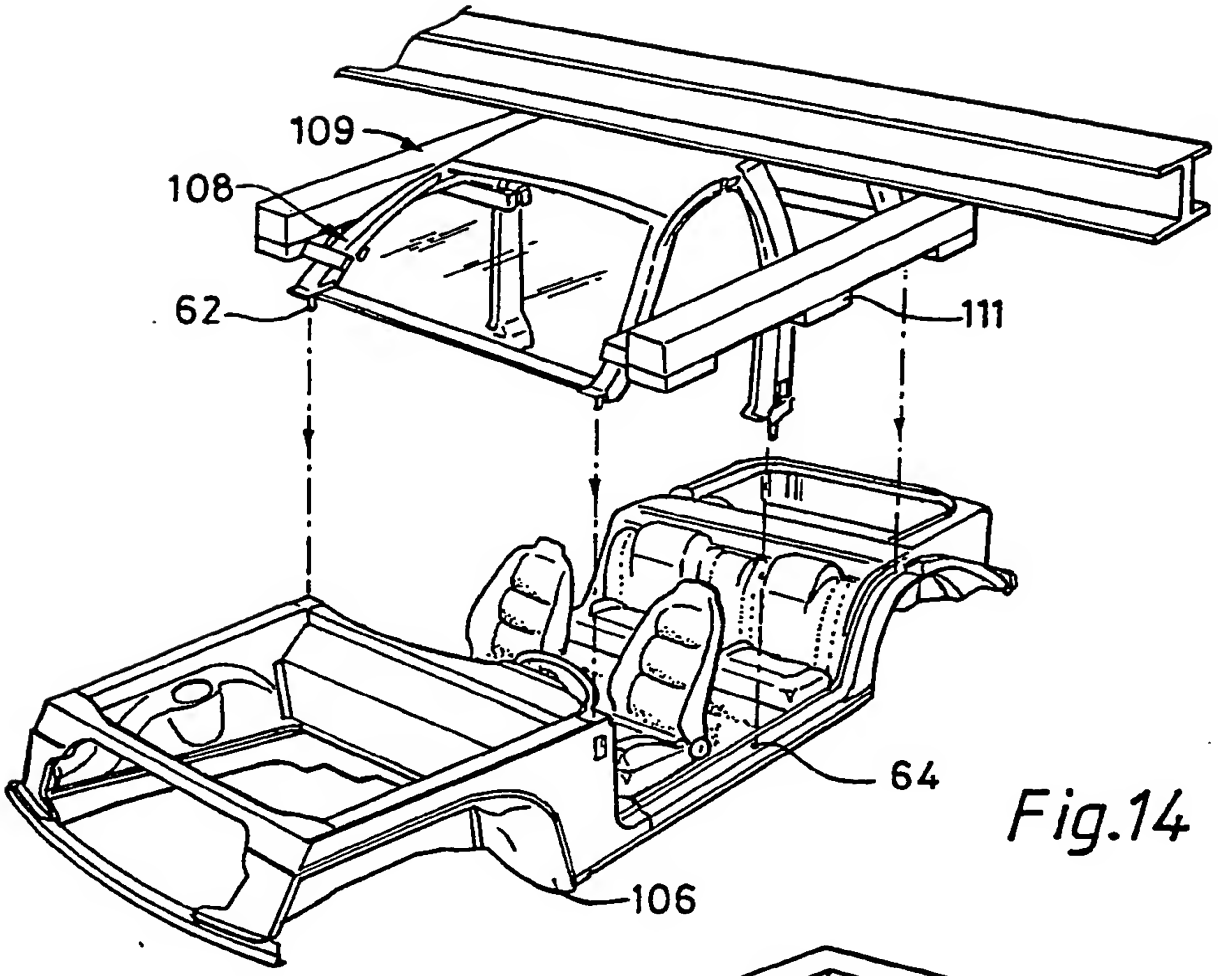


Fig.14

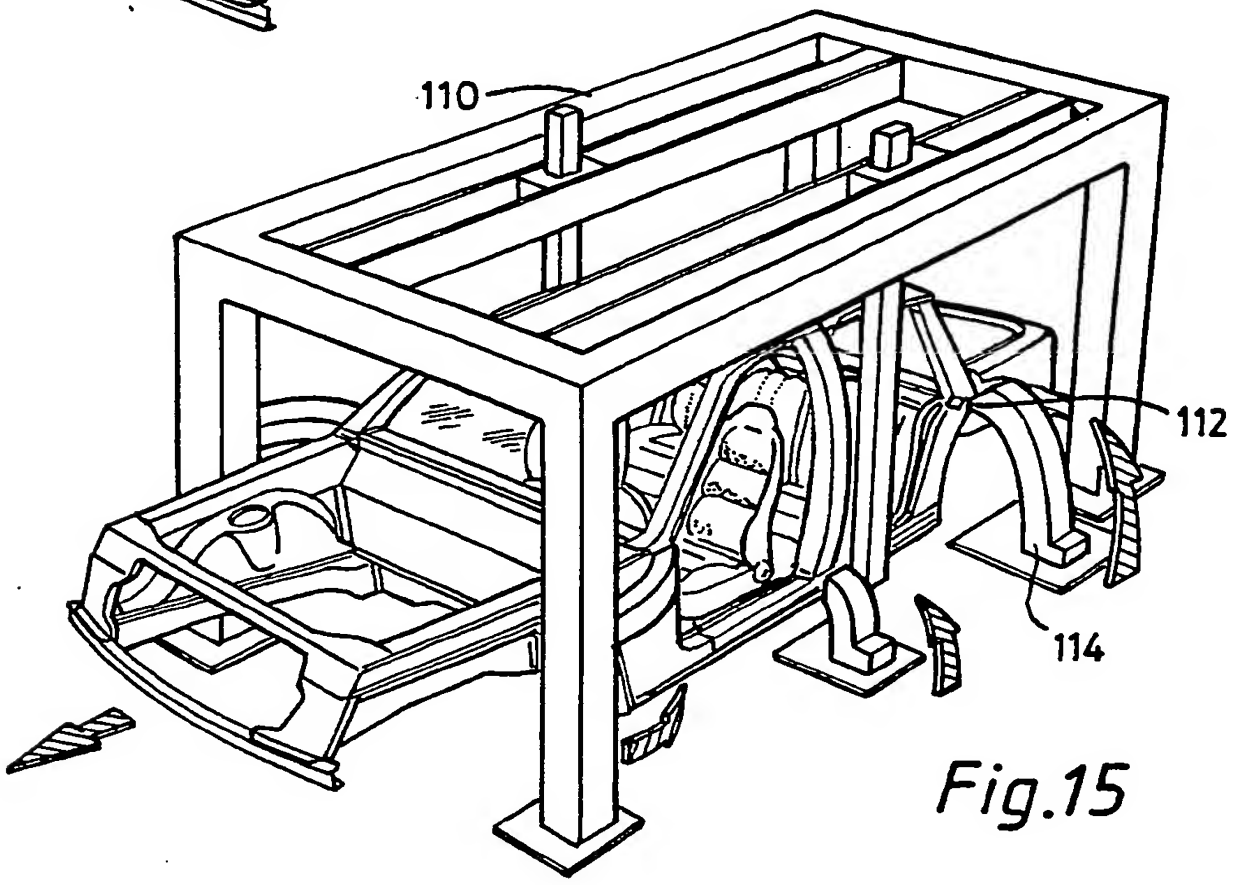


Fig.15

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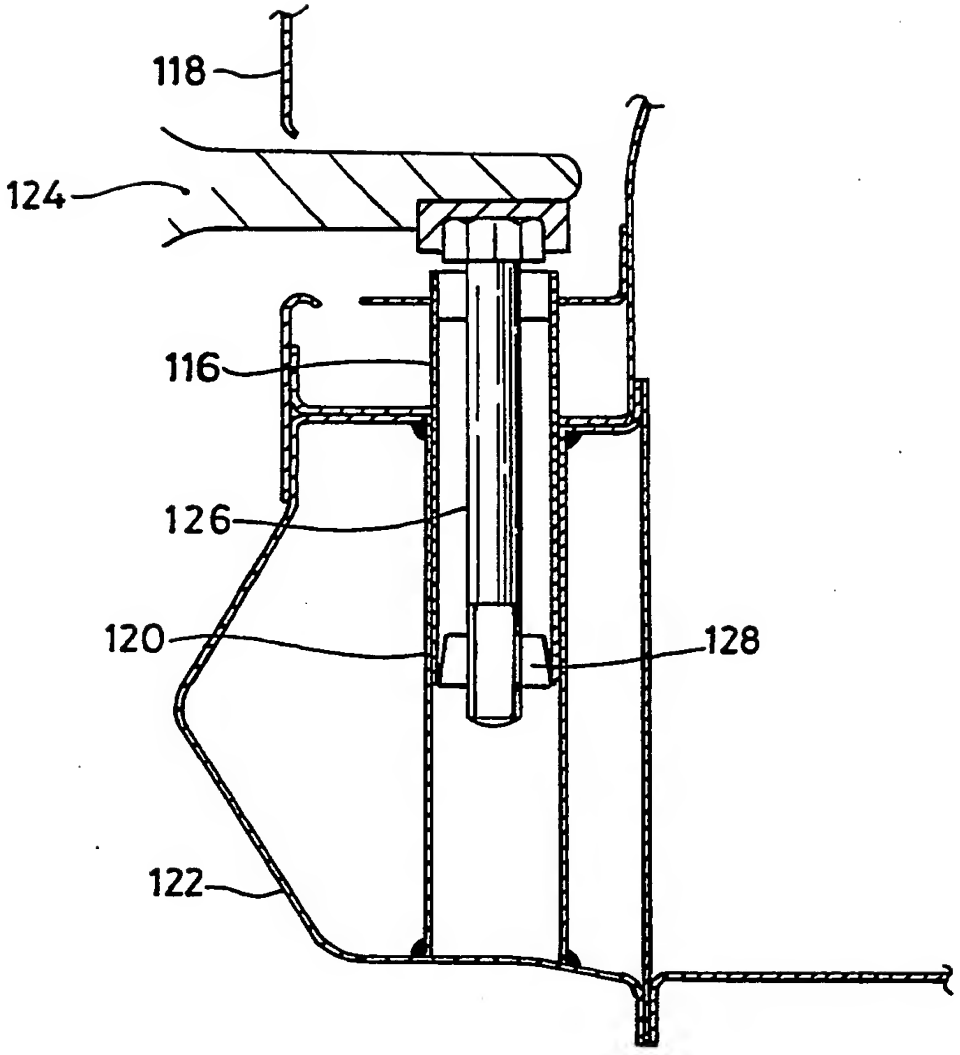


Fig.16

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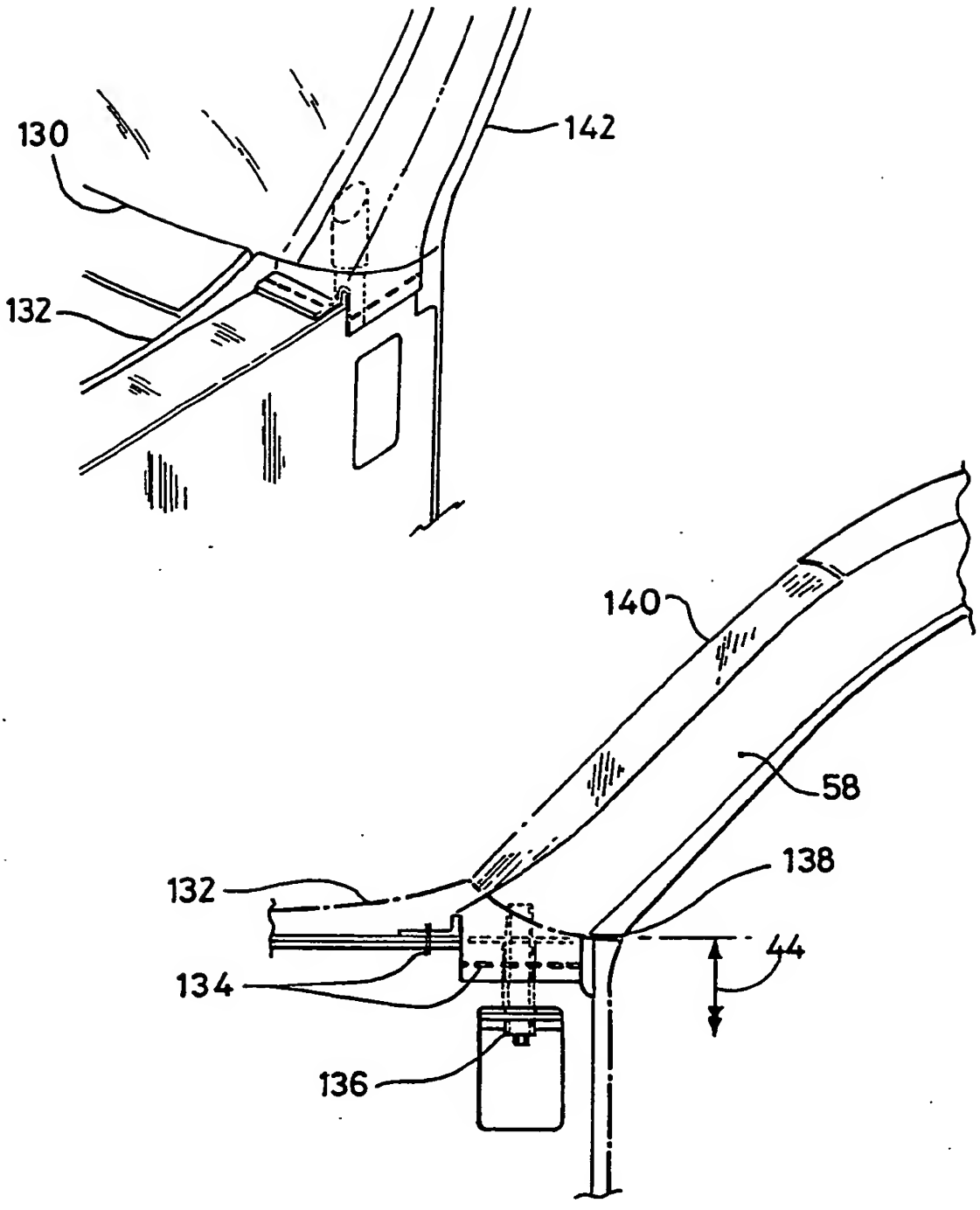


Fig.17

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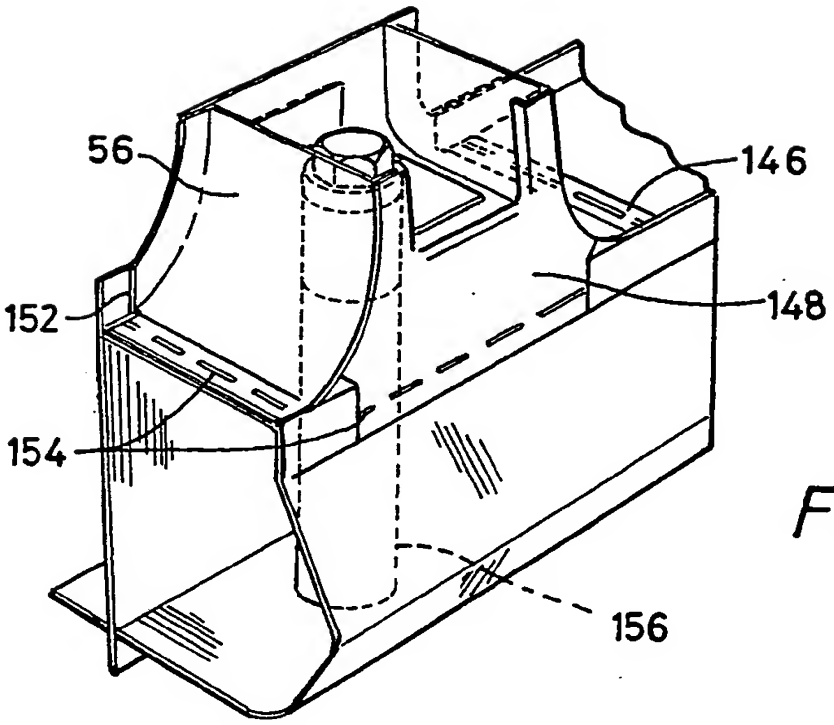


Fig.18

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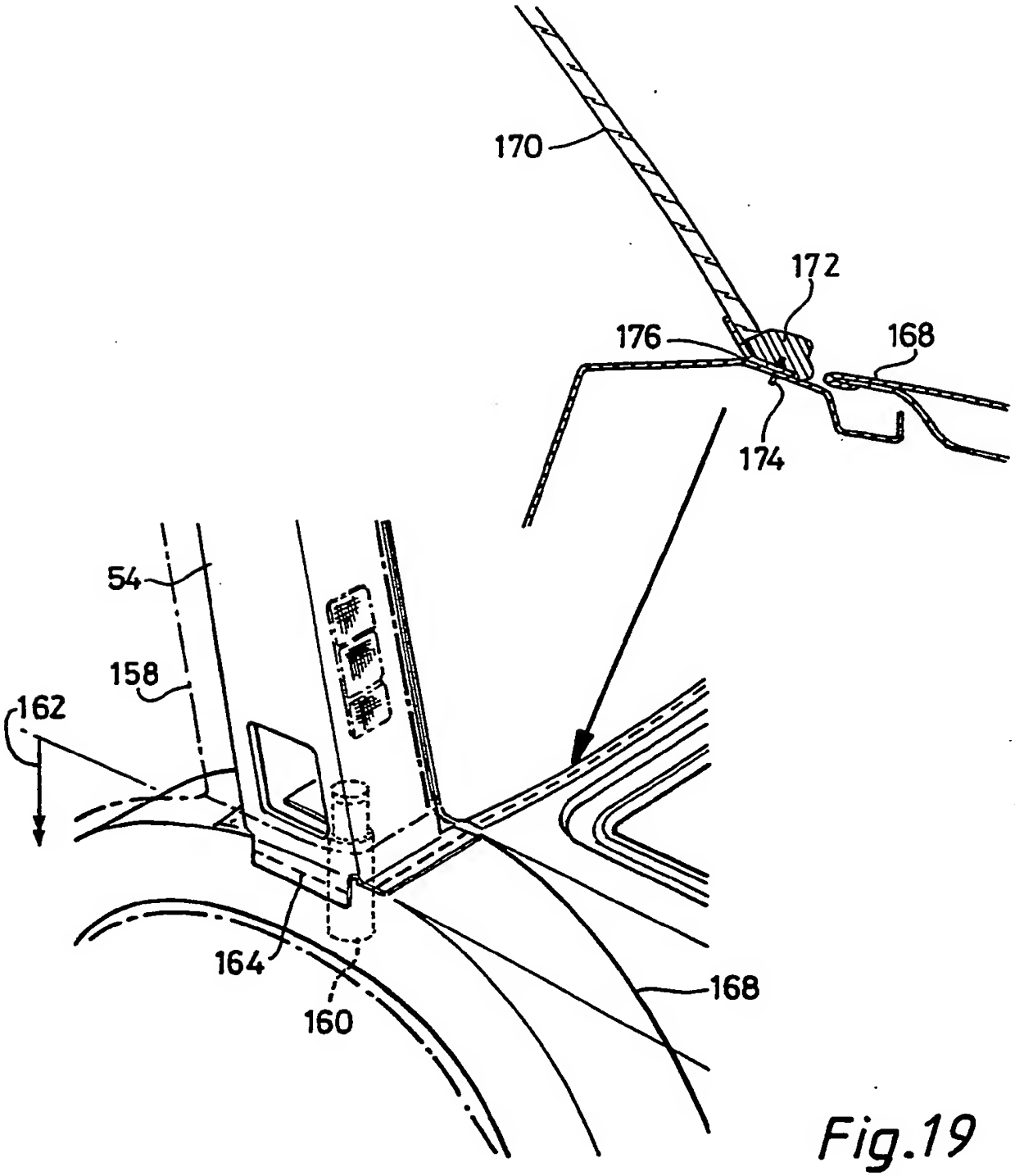


Fig.19

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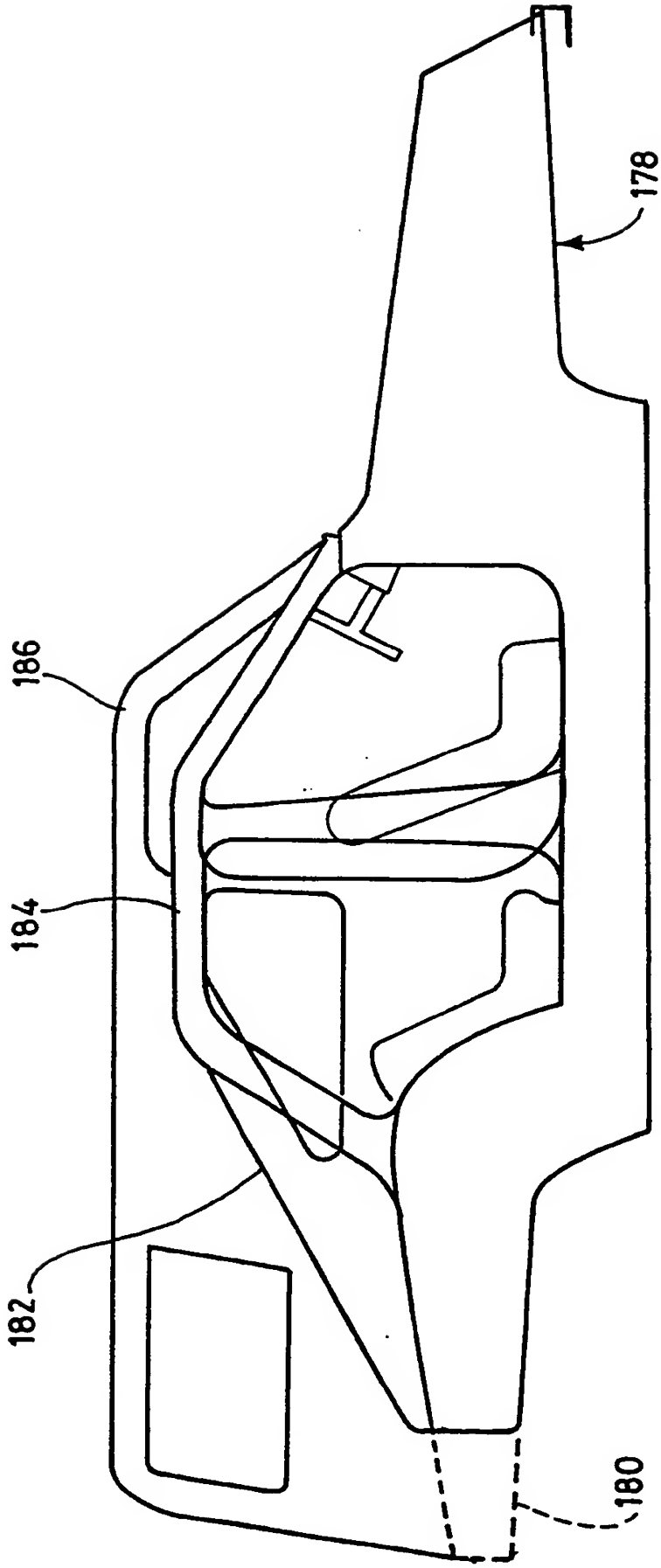


Fig. 20

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European Patent Office

# EUROPEAN SEARCH REPORT

Application number

EP 86 30 7255

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (Int. Cl.4) |
|---|---|---|---|
| P,X | PATENT ABSTRACTS OF JAPAN, vol. 10, no. 270 (M-517)[2326], 13th September 1986; & JP - A - 61 92965 (TOYOTA) 10-05-1986 (Cat. X) | 1 | B 62 D 65/00<br>B 62 D 27/02 |
| X | DE-A-3 035 333 (DAIMLER-BENZ)<br>* claims 2, 3, 6; figure 1 * | 1 | |
| X | EP-A-0 171 576 (OPEL)<br>* abstract; figure 1 * | 1 | |
| A | DE-A-2 923 874 (AUDI)<br>* claim 1; figure 1 * | 1 | |
| A | FR-A-2 384 666 (DEBRECZENY et al.)<br>* claim 1; figures 1-3, 9 * | 1 | |

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

B 62 D 65/00
B 62 D 23/00
B 62 D 25/00
B 62 D 27/00

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| BERLIN | 11-09-1987 | KRIEGER P O |

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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& : member of the same patent family, corresponding document

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